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SAN JOSE
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M-129774S

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**MOSEL VITELIC
INVENTION DISCLOSURE**

The purpose of this form is to secure the disclosure and a record date of your invention. It should be filled out as thoroughly as possible and returned to a committee member for processing. A separate form should be used for each invention or modification of the invention. The last sheet should be signed and dated by the inventor(s).

All of the following entries should be made in ink or type, without erasures or the use of "liquid paper". Errors should be lined out.

I. Give a descriptive title of the invention:

A method to prevent metal etch micromasking residue due to surface roughness/residue present after an ex-situ PETEOS hardmask open etch

II. Give a clear and concise description of how to make and use the invention. The preferred method is to attach copies of the description from your Patent Notebook. The original pages in your notebook should have been signed, witnessed and dated.

Alternatively, use the attached blank Invention Description Form to describe how to make and use your invention. Novel aspects of your invention should be described fully, while aspects generally known *per se* in the art need be described only generally. If needed, you may attach separate drawings or prints and descriptions (properly signed, witnessed and dated, if possible).

Make as many copies as necessary of the blank Invention Description Form attached. Number the pages used in the description consecutively. Use ink and print or type all material except the signatures of the inventor(s) and witnesses on every page. Note that two witnesses are required, each of whom has read and understood the technical content of the disclosure. Also the department head should review and sign all pages.

COPY
Redacted Exhibit A,
page A.1

III. Background information on the invention:

A. What are the objects of the invention?

The objective is to eliminate pre-metal etch residue/or roughness that will subsequently serve as micromask during metal etching.

B. What problem(s) is/are solved by the invention?

By eliminating micro masking occurrence during metal etching subsequently will prevent post etch-metal line bridging.

C. What were the previous methods or apparatus that were used but failed to solve the problem? (Give source of previous information on the subject that is closest to your invention, such as known use, publication or patents.)

The over etch step in an oxide etch chamber using equipped traditional gas chemistry will not rid of this residue/roughness layer nor using BOE(buffered oxide etch) during wet etch.

D. State how the present invention differs from previous methods or apparatus and what advantages it provides.

The current invention utilize different process chemistry as offered by an oxide etch chamber. Instead, we use gas chemistry in a metal etcher together with a typical gas and power ratio setting prior to metal arc etch step(or break thru step) to eliminate roughness surface. The entire multi-step process is done sequentially in a metal chamber without air break(in-situ)

IV. What is the prospective value or utility of the invention for the Company?

Capital expenditure saving by prolonging the use of aluminum as a metal interconnect scheme in the BEOL by at least one generation.

Defect reduction at metal etch and potential higher die yield

V. Give the Project No. which covers the work done, if any, and identify any monthly or other issued report. (Attachment of pertinent pages would be helpful.)

A. 2

See attachment and process module presentation PMR [REDACTED] wt and PMR [REDACTED]

VI. Have information, samples or technical bulletins relating to this invention been given to any customer, have products relating to invention been sold, or has the process involved been used on a commercial scale? If the answer is yes, please give date and other details.

None

VII. When did you first think of this invention?

[REDACTED]

VIII. What records do you have to substantiate this conception date? (Notebook numbers and pages, letters, reports, etc.) What is the date of first written description and/or drawing?

In-line SEM micrographs, monthly progress presentation, clean room note book

IX. When did you first do any actual experimental work toward carrying out the invention? Give Dates, patent notebook and page numbers:

[REDACTED]

X. When and how did you make the first disclosure of the invention to others either orally or in writing?

During process module presentation on [REDACTED]

XI. Give the date and description of past or future publications.

None

A.3

XII. Is further experimental work now under way or contemplated for the near future?

If so, give a general summary of such work and some idea of when this phase of the program will be completed.

The concept and feasibility of this project is completed, the alpha phase of the development will carry on when need arrive

XII. Was this invention developed under a Government Contract? If yes, give the contract number.

No

XIV. Furnish the following information for each inventor:

| | | | |
|---------------------|----------------------------|-------------|------------|
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| City, County, State | <u>Saratoga, CA 95070</u> | | |
| Supervisor | <u>George Kovall</u> | | |
| Signature | | Date | |

| | | | |
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| Name In Full | <u>Yi Ding</u> | Citizenship | <u>Singapore</u> |
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| Supervisor | <u>Hsiao, J.S.</u> | | |
| Signature | | Date | |

| | | | |
|---------------------|---------------------------|-------------|------------|
| Name In Full | <u>George Koval</u> | Citizenship | <u>USA</u> |
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| Supervisor | <u>Ching-Hwa Chen</u> | | |
| Signature | | Date | |

A. 4

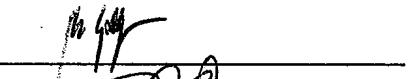
INVENTION DESCRIPTION FORM

Page ____ of ____.

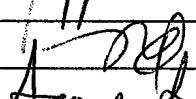
Invention Title: A method to prevent metal etch micromasking due to surface roughness/residue present after an ex-situ PETEOS hardmask open etch**Inventor:** Wood K. Sattayapiwat Yi Ding George A Kovall
first inventor second inventor third inventor**Description of the invention (use ink)**

This invention provides a method to eliminate metal etch residue resulting from surface roughness and/or residue prior to metal etch, which could result in metal bridging failures. This Invention pertains to an oxide hard mask on a TiN capped metal stack, though it potentially can be used for other mask and metal stack configurations. The oxide hard mask is etched in a conventional oxide etcher prior to transferring to the metal etch chamber, and the roughness/residue that remained after oxide hard mask etch prior to metal etch was not removable by using a traditional fluorine-based oxide etch process. This indicated that the residue may not be purely silicon oxide residue, but perhaps is an intermediary film resulting from the interaction between the PECVD oxide and the TiN cap layer on the metal.

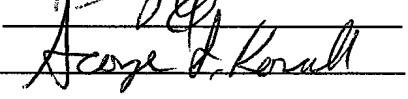
Prior to the conventional metal etch recipe step, a chlorine based etch step was added with the appropriate conditions to ensure sufficient sputter-enhanced etching of the surface in order to reduce the height of the roughness/residue. Since the height of the residue is reduced prior to etching the bulk metal, residue resulting from surface micromasking can be eliminated. The process conditions that were selected address the surface roughness/residue as not primarily silicon oxide in nature, but also having a metallic component.

First Inventor Signature: 

Date: _____

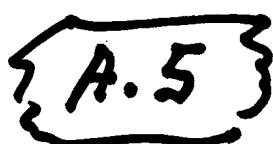
Second Inventor Signature: 

Date: _____

Third Inventor Signature: 

Date: _____

Date: _____



1) TiN cap 60 Å Temp 60°C

2) initial Co thickness = 150 Å

SC1

SC1 1:1:15 @ 60°C

SC2 1:1:10 @ 60°C

HCo : $Co_2Cr_2O_4$

1:1:4 @ 60°C

Industry process

5 min : 5' SPM

10' SC1 : 5' SPM

5' SC1 :

5' SC1 :

10' SC1 : 15' SC2

Moltena position SPM is a proven process

SC1:SC2 sequence is comparable to SPM process

Selectivity # Co : CoSi₂ remains stable

Two uses SC1:SC2

① SC1:SPM

② SC1:SC2

③ Ptransistor

Gov. Andriev Tsai

Krib, Bb, Joann

5 wif

SPM 724 - 22

PIME 11w15w

21 25 14

→ State: 11w15w
@ 9.2 nm Ar5 1+2 DAT 5631

WZ (SPM, Surface Tension, Dyn) ~ Marangoni

WZ (0.72 - 25) ~ 34 Sint Amstelco for dem

724(784) - 22, 20, 24, 25, 14 0721 - 10

WZ ~ 1159 by Ar5a 1+1

num 8Ar5a Ep: 39" on 724(784) - 22 DAT = 5674, 12°3

Ar5a wif 22

IN#1 ~22V -64V

IN#2 ~52V -53V

ME ~63V ~78V, Ep: 39"

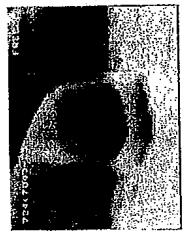
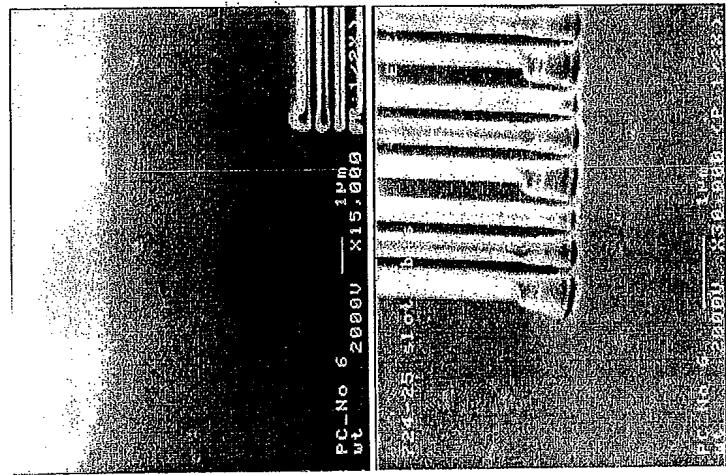
OE1 ~78V -82V

OE2 ~78V -82V

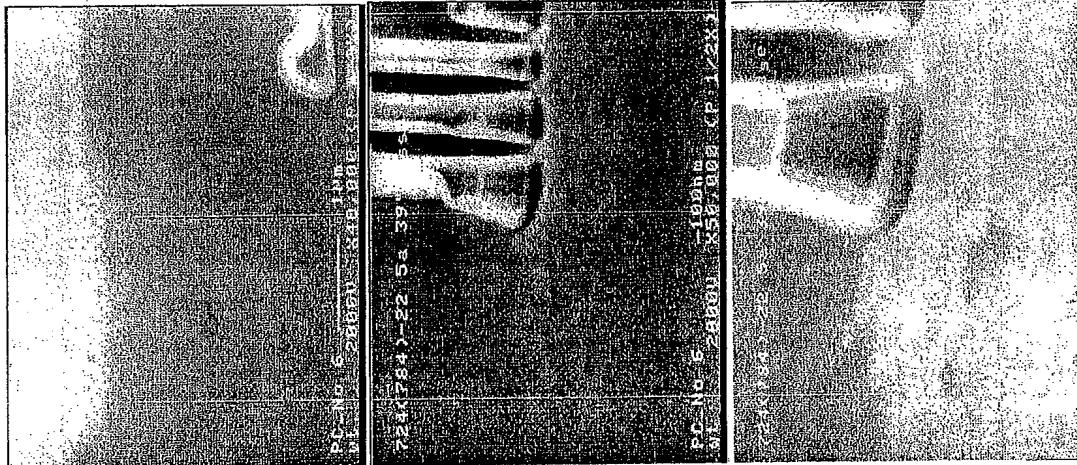
A.7

Comparison with and without sputter etch

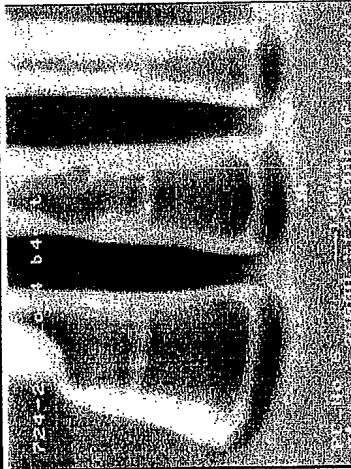
WF 724(784)-25



MOSEL VITELIC



WF 724(784)-22



3 A.8

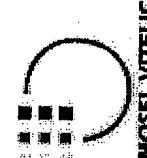
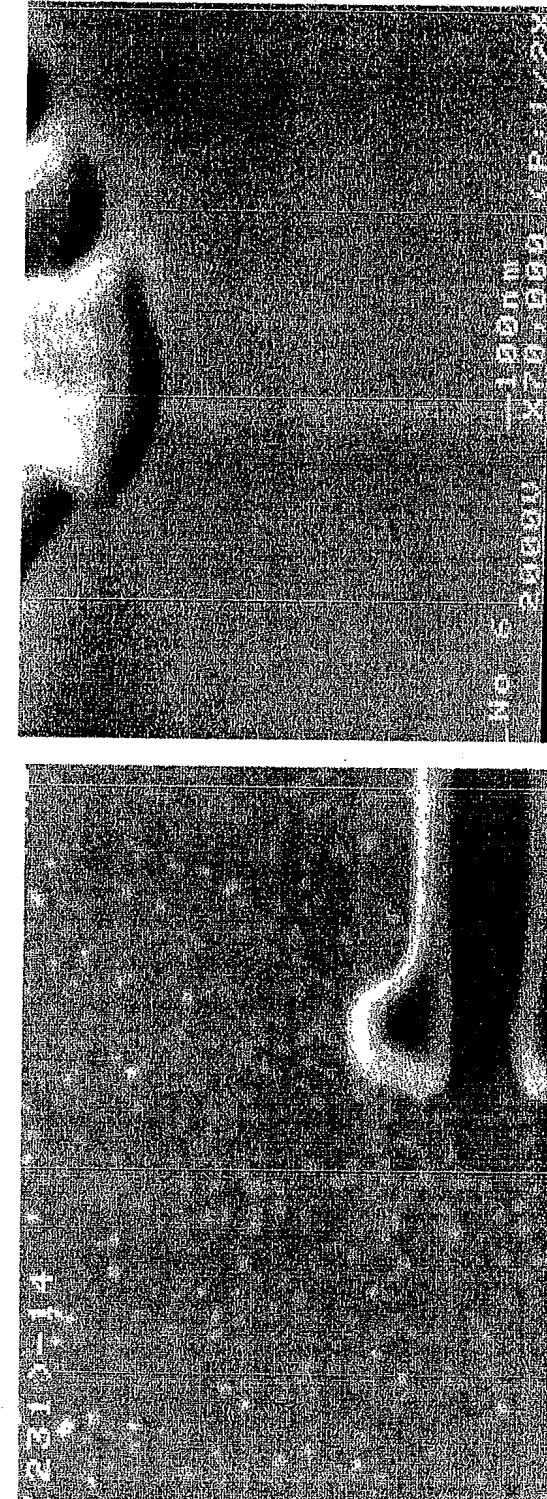
6.3
A

693(231)-14

NA=6

Before

After



MOSEL VITELIC

A.9